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VEHICLE HEATING AND COOLING SYSTEM

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Priority Claim:

This invention claims priority to provisional application Serial No. 60/416,633, filed 10/07/2002.

1. Field of the Invention

This invention relates in general to heating and cooling systems for vehicles, and in particular to a system utilizing an auxiliary engine.

2. Description of the Prior Art

Large tractor trucks typically have an air-conditioning systems similar to automobiles. The truck engine drives a compressor that compresses refrigerant and delivers it to a condenser. The condenser converts the hot gaseous refrigerant to a liquid refrigerant. The refrigerant flows to an evaporator where it undergoes a pressure drop, converting the refrigerant to a cold gas. An interior fan flows air through the evaporator into the interior of the vehicle. The condenser is cooled by the main engine fan, which also flows air through the engine radiator.

For heating, a heater coil or element is mounted in the vehicle in communication with the radiator via hoses. A portion of the hot engine coolant flows through the heater coil. The interior fan flows air through the heater coil to heat the interior of the vehicle.

Many large trucks have sleeper compartments attached to the cab for allowing the driver to rest. In most cases, for heating and cooling, the operator continues to operate the main truck engine at idle while he is sleeping in order to run the air-conditioner or heater. The main engine generates far more power than needed for heating and cooling, consequently considerable fuel is consumed while the driver is resting.

Generators have been mounted to large trucks for generating 110 volt AC power. An auxiliary engine, normally diesel, is located in a compartment along with a generator. In these cases, a separate 110 volt air-conditioning unit mounts to the sleeper compartment or cab. The air-conditioning unit has an electrical motor that drives the compressor and the fan. For heat, an electrical resistance element may be employed, or the air-conditioner may be operated as a heat pump. Heating by a 110 volt air conditioner unit, however, consumes a considerable amount of power.

Another approach for heating and cooling while the truck is stopped is to utilize a 110 volt air conditioning unit and a power cord that extends to a power service receptacle at a rest stop. Many rest stops, however, do not have such provisions for connecting a vehicle to electrical power.

Other vehicles that have a need for air-conditioning and heating may not have a primary engine. These vehicles include recreational trailers and horse trailers. Generally, owners of trailers rely on being able to connect a power cord to a power receptacle. Heating and cooling is handled by a conventional 110 volt air conditioner mounted to the trailer.

3. Summary of the Invention

In this invention, an auxiliary engine is mounted in a housing, which in turn is mounted to the vehicle, whether it is a truck or trailer. The auxiliary engine has an electrical generating device that generates electricity. The generating device may be an alternating current generator or it may be a conventional DC alternator. The auxiliary engine is liquid cooled and has a radiator for receiving engine coolant flowing from the auxiliary engine. A heater coil or element is in fluid communication with the radiator for receiving at least part of the engine coolant flowing from the auxiliary engine. A fan causes flow through the heater element into the interior of the vehicle, the fan being powered by the electrical generating device.

For cooling, a compressor, condenser, and evaporator are utilized. The compressor is powered by the auxiliary engine, either directly or by an electrical motor that receives its power from the generating device. The evaporator is mounted adjacent the heater element so that air from the fan flows through the evaporator into the interior of the vehicle.

Also, in one of the embodiments, the heating and air-conditioning system is pre-charged with refrigerant and enclosed within a single integral housing prior to mounting it to the truck. The housing has first, second and third compartments adjoining each other. The auxiliary engine is mounted in the first compartment of the housing along with the compressor. A radiator and condenser are mounted in the second compartment. Preferably, the second compartment is elevated relative to the first compartment so as to avoid ice freezing on the radiator and condenser during icy weather. The evaporator, heater element and interior fan are mounted in the third compartment. Ducts extend directly from the third compartment into the interior of the vehicle for supplying and returning conditioned air. The integral unit is readily mounted to the truck, and requires no charging of refrigerant after installation.

4. Brief Description of the Drawings

Figure 1 is a side elevational view of a truck having an auxiliary air-conditioning and heating unit in accordance with this invention.

Figure 2 is a schematic of the air-conditioning and heating system of the truck and of the unit of Figure 1.

Figure 3 is en exploded view of a portion of the auxiliary heating and cooling unit of Figure 1.

Figure 4 is a sectional view of the auxiliary heating and cooling unit of Figure 1, taken along the line 4- -4 of Figure 3.

Figure 5 is a sectional view of the auxiliary heating and cooling unit of Figure 1, taken along the line 5- -5 of Figure 4.

Figure 6 is a schematic of an alternate embodiment of an auxiliary heating and cooling unit.

5. Detailed Description of the Invention

Referring to Figure 1, truck 11 has an engine compartment 13 and a cab 15. Optionally, truck 11 may have a sleeping compartment 17. The interior of sleeping compartment 17 is in common with the interior of cab 15.

An auxiliary air conditioning unit 19 is shown mounted to frame 21 of truck 11. Air-conditioning unit 19 is located at the rear of and below sleeping compartment 17 in this embodiment. In this embodiment, auxiliary air-conditioning unit 19 is located rearward of a fuel tank 23. Typically, truck 11 will also have a step box 25 located directly below cab 15 in front of fuel tank 23 for providing access to the interior of cab 15.

As shown in Figure 2, truck 11 has a main or primary engine 27 that propels truck 11. Normally, engine 27 is a diesel. A main radiator 29 is connected by hoses to main engine 27 for receiving engine coolant. An engine fan 30 is directly driven by main engine 27 for causing air to flow through main radiator 29. Truck 11 also has a main interior heater element or coil 31 and a main interior fan 33. Heater 31 is connected by hoses to radiator 29 for receiving a portion of the flowing engine coolant. Fan 30 causes air to move through heater coil 31 for heating the interior of cab 15 and sleeping compartment 17. Valves (not shown) controlled by the driver will selectively provide or stop flow of engine coolant through heater 31.

For cooling, engine 27 drives a main compressor 35 by a belt (not shown). Compressor 35 delivers hot gaseous refrigerant to a main condenser 37 that is mounted parallel to radiator 29. Condenser 37 condenses the refrigerant to a liquid, which flows to a main evaporator 39. Typically, the same interior fan 33 causes air to flow through evaporator 39 into the interior of cab 15. Main engine 27 also drives a main alternator 41 by a belt. Alternator 41 supplies electrical power for interior fan 33 as well as lights and other accessories.

Auxiliary air-conditioning unit 19 includes a housing 43. In this embodiment, housing 43 is a single integral unit having three compartments 45, 47 and 49. Compartments 45, 47 and 49 are secured to each other, but preferably sealed from the each other.

An auxiliary engine 51 is mounted in first compartment 45. The term "auxiliary" is used herein to mean an engine that does not supply the power to move the vehicle. Auxiliary engine 51 is preferably a small diesel engine. In one embodiment, auxiliary engine 51 has a single cylinder that is horizontally oriented. Auxiliary engine 51 preferably receives its fuel from fuel tank 23 (Figure 1). Auxiliary engine 51 drives an auxiliary compressor 53, preferably with a belt. Auxiliary engine 51 also drives an auxiliary alternator 55 in this embodiment with a belt. Compressor 53 and alternator 55 are located along with auxiliary engine 51 in first compartment 45.

An auxiliary radiator 57 and an auxiliary condenser 59 are located in second compartment 47. As shown also in Figure 3, radiator 57 and condenser 59 are parallel to each other and separated to receive an auxiliary fan 61 between them. Fan 61 is driven by an electrical motor, which in turn is powered by alternator 55 (Figure 2). Protective grids 62 are on opposite sides of second compartment 47 to provide protection to the coils contained in radiator 57 and condenser 59. Although fan 61 is shown located between radiator 57 and condenser 59 in this embodiment, other variations are feasible such as locating radiator 57 and condenser 59 in contact with each other or at angles relative to each other.

Referring again to Figure 2, auxiliary radiator 57 is connected by hoses to auxiliary engine 51 for receiving and cooling engine coolant. Condenser 59 is connected by lines to compressor 53 for condensing hot gaseous refrigerant into a liquid. Second compartment 47 is preferably located on top of first compartment 45. This positions radiator 57 and condenser 59 at a higher elevation than auxiliary engine 51 to reduce the possibility of ice accumulating on grids 62 during icy weather. In this embodiment, second compartment 47 has the same lateral dimension from its inner side to its outer side as first compartment 45. However, the longitudinal dimension from the forward grid 62 to the rearward grid is less than the longitudinal dimension of first compartment 45.

Condenser 59 also has an output line that leads to an evaporator 63. Evaporator 63 is located in third compartment 49. Evaporator 63 includes an expansion valve that reduces the pressure of the refrigerant, causing it to convert to a cold gas. The refrigerant returns from evaporator 63 by a line to compressor 53. Additionally, an auxiliary heater coil or element 65 is located in third compartment 49. Auxiliary heater 65 is connected by hoses to radiator 57 for receiving a portion of the hot engine coolant running through radiator 57. Valves (not shown) selectively close the coolant flow through heater 65 while it is not operating.

An auxiliary interior fan 67 is also mounted in third compartment 49 for circulating air through heater 65, evaporator 63 and the interior of cab 15 and sleeping compartment 17. Fan 67 is driven by an electrical motor powered by alternator 55.

As shown also in Figure 5, third compartment 49 has a supply duct 69 that leads to mating ductwork of sleeping compartment 17 or directly into the interior of sleeping compartment 17. Supply duct 69 is in communication with a supply plenum 71 that forms a part of third compartment 49. A return duct 73 returns air from the interior of sleeping compartment 17 into a return plenum 75. Fan 61 is preferably a squirrel cage blower located within return plenum 75. In this embodiment, heater coil 65 and evaporator 63 are mounted at a 90° angle relative to one another. Fan 67 discharges air through heater coil 65 and evaporator 63 into supply plenum 71. Other variations of heater 65 and evaporator 63 are feasible, such as mounting heater 65 and evaporator 63 parallel to each other.

Referring again to Figure 3, third compartment 49 is located on the forward side of first compartment 45 at a lower elevation than second compartment 47. Third compartment 49 also has the same lateral dimension as first compartment 45 from its inner side to its outer side. However, its longitudinal dimension from its forward side to its rearward side is less than first compartment 45 in this embodiment.

During assembly of the embodiment of Figures 1-5, air-conditioning unit 19 is assembled as an integral operable unit in compartments 45, 47, 49 of its housing 43. The refrigerant within air conditioning unit 19 is pre-charged. Unit 19 is then typically shipped to another facility for installing it on truck 11. Housing 43 is then bolted to frame 21, and ducts 69 and 73 (Figure 5) are inserted into mating ducts or receptacles within sleeping compartment 17. A fuel line is connected from fuel tank 23 to auxiliary engine 51. An electrical cable is connected from the main batteries (not shown) of truck 11 to the starter of auxiliary engine 51. A control box (not shown) for starting auxiliary engine 51 and controlling air conditioning unit 19 is installed in the interior of sleeping compartment 17 or cab 15. Air conditioning unit 19 is then ready for operation.

During operation, while driving truck 11, the operator would normally utilize only the main heating and cooling system. In cold weather, the operator would utilize main heater 31 and main interior fan 33. In hot weather, the operator would turn on the compressor 35, which results in cold air flowing through evaporator 39 into the interior.

When truck 11 is stopped and main engine 27 is turned off, the operator starts auxiliary engine 51 if heating or cooling is desired. If the weather is cold, the operator can heat the interior of sleeping compartment 17 and cab 15 by opening valves to allow auxiliary engine coolant to flow from auxiliary radiator 57 through heater coil 65. Auxiliary fan 67 causes air to flow through heater coil 65 and out supply duct 69. The air returns by return duct 73.

If the weather is hot, the operator turns on the air conditioning portion of unit 19. Auxiliary engine 51 directly drives compressor 53, which supplies pressurized gaseous refrigerant to condenser 59. The refrigerant flows to evaporator 63, where it is expanded and flows back to compressor 53. Fan 67 discharges air through evaporator 63 and out supply duct 69 into the interior of sleeping compartment 17. The air circulates back through return duct 73.

Although it facilitates assembling to combine the three compartments 45, 47 and 49 into a single integral housing 43, such is not essential. For example, third compartment 49 could be completely separate from first and second compartments 45, 47 and mounted to the floor or a wall of sleeping compartment 17. The components in the first and second compartments 45, 47 could optionally be mounted in step box 25.

Figure 6 shows another embodiment. Truck 77 has the same primary components as truck 11 of Figure 1. The main components include an engine 79, radiator 81, and engine fan 83. Truck 11 also has a heater 85 and an interior fan 87 for discharging air through heater 85. Truck 77 also preferably has a compressor 89 driven by main engine 79. Compressor 89 is connected to a condenser 91 and evaporator 93. An alternator 95 supplies power for accessories and various fans of the system.

In this embodiment, the generating device that is employed generates 110 volt AC power, rather than DC power as in the first embodiment. Housing 97 is mounted to the frame of the truck 77 and contains an auxiliary diesel engine 99. Engine 99 is a liquid cooled engine of the same type as auxiliary engine 51 of Figure 1, although it may be of a higher horsepower. A radiator 101 receives engine coolant from auxiliary engine 99 for cooling. A fan 103, preferably driven by an electrical motor, causes air to flow through radiator 101. In this embodiment, radiator 101 is located in the same housing 97 as auxiliary engine 99.

A 110 volt AC generator 105 is mounted to auxiliary engine 99. Preferably, auxiliary engine 99 drives generator 105 through a belt drive system. A separate air-conditioner unit housing 107 is mounted to a floor or wall of the sleeping compartment of truck 77. A compressor 109 is driven by an AC electric motor 111 for compressing refrigerant. Condenser 113 is also mounted in housing 107. An evaporator 115 and an interior fan 117 may also be located within housing 107. A heater 119 is preferably located in housing 107 adjacent to evaporator 115. Heater 119 is connected by hoses to radiator 101 for receiving at least a portion of the engine coolant. Interior fan 117 optionally causes air to flow through condenser 113, or another fan may be employed for that purpose.

In the operation of the embodiment of Figure 6, while truck 77 is stationary and main engine 79 shut off, auxiliary engine 99 is started if heat or cooling is needed. Auxiliary engine 99 supplies AC electrical power through generator 105. This power drives motor 111 if the air-conditioner is being operated. Motor 111 drives compressor 109, which cycles refrigerant through condenser 113 and evaporator 115. Fan 117 discharges air through evaporator 115 to cool the interior of truck 77. For heating, the operator causes some of the coolant to flow through heater coil 119. Fan 117 operates to discharge air through heater coil 119 into the interior.

The invention has significant advantages. By connecting a heater coil to a liquid cooled auxiliary engine, heat can be supplied to the interior of a truck or trailer without the need for electrical resistance elements or a heat pump air conditioning unit. The operator can obtain heating and cooling without operating the main engine. The compartments of the integral housing facilitate assembly into a truck or trailer.

While the invention has been shown in only one of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes without departing from the scope of the invention.